Metallic A-type Antiferromagnetic State in a Layered Manganite

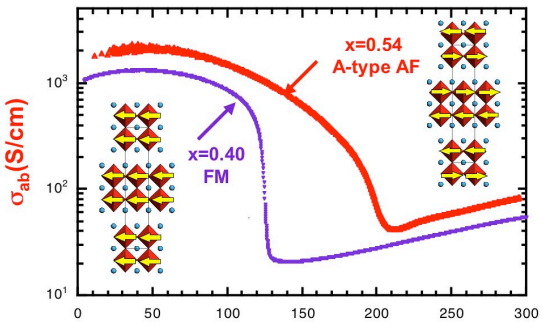
E. Badica, K. E. Gray, J. F. Mitchell and H. Zheng

Our motivation is to understand conduction in the colossal magnetoresistive manganites.

For example, metallic conductivity and ferromagnetic (FM) order have been thought to symbiotically coexist.

Our observation of a metallic A-type AF manganite belies this simplification.

Based on this we propose a phenomenological model for charge localization in manganites.



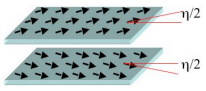
Layered manganite for x=0.54, that exhibits A-type AF order, unexpectedly shows metallic conductivity and also higher T_c than the fully FM manganite at x=0.40

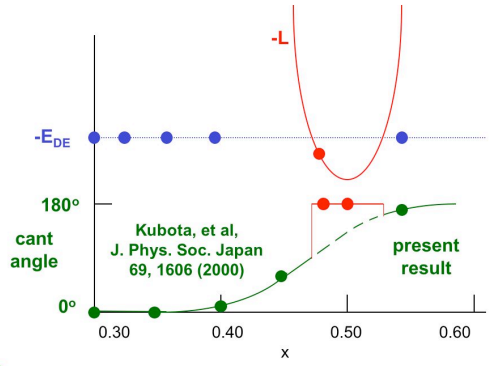
Phenomenological Model

introduce localization energy (L) in addition to superexchange (SE) and double exchange (DE)

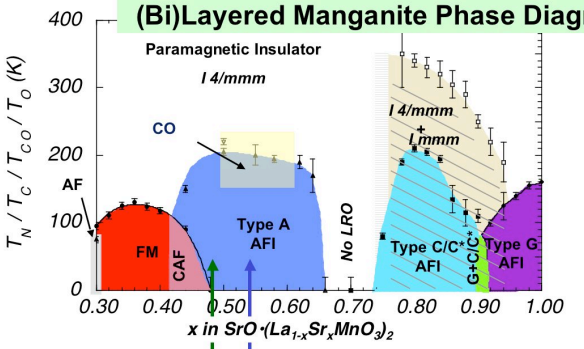
$E_{loc}(\eta) = J_{SE}\cos(\eta) - L$

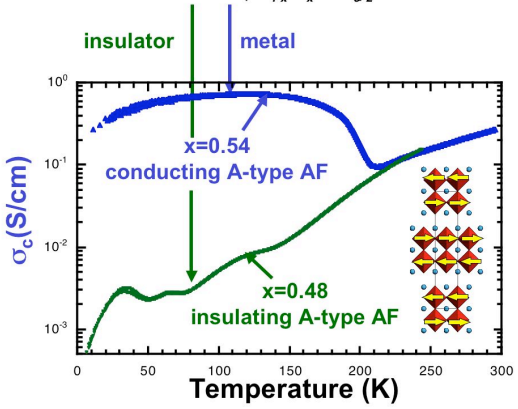
$E_{deloc}(\eta) = J_{SE}\cos(\eta) - J_{DE}\cos(\eta/2)$





(Bi)Layered Manganite Phase Diagram





Two layered manganite for x=0.48 and 0.54, that show A-type AF order from neutron scattering, exhibit quite different conduction, metallic and localized

From the small c-axis metallic conductivity and magnetization, we conclude that A-type AF state for x=0.54 is very slightly canted, as it must be since double exchange wins out over localization

Implications

Phenomenological model could provide the 'something else' than double exchange needed to understand colossal magnetoresistance
Millis, et al [*Phys. Rev. Lett.* 74, 5144 (1995)]

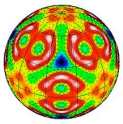
Future directions

Seek theoretical justification of phenomenological model (with theory group)

Examine other compositions above x=0.50

Study magnetic and electronic properties of surfaces Vs. x to test predictions of phenomenological model
(begun with John Freeland at APS)

Qing'An Li, K.E. Gray, A. Berger and J.F. Mitchell, Phys. Rev. B67 184426 (2003)



BES - DOE

This work was supported by the U. S. Department of Energy, Basic Energy Sciences, under contract W-31-109-ENG-38.

MSD - ANL

ARGONNE NATIONAL LABORATORY
UNIVERSITY OF CHICAGO